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One of the goals of this research was the measurement of H2(v equal 1) and H2(v equal 2) formed by the reaction of H with HI. The technique used is quantitative absorption spectroscopy on various absorption bands of H2 near 1100 angstroms in the vacuum ultraviolet. Preliminary calculations indicated that features due to HI in this region would be sufficiently weak under the desired operating conditions that quantitative spectroscopy of the transitions from the vibrationally excited H2 could be performed. This proved not to be →over

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the case. Pressures on the order of 10 to 100 millitorr of HI obscured the bands in this region. The signal/noise ratio of the original apparatus which employed sodium salicylate to down convert the vacuum ultraviolet photons to near uv-visible ones was inadequate to the task of unraveling the spectrum. Subsequent equipment improvements have reduced the source noise. The spectrometer and pressure guage have been modified and interfaced to a digital computer. The analysis software determines the equivalent widths of the spectral features and converts these to pressures of H2 in specific (v, J) states. The flow system and reaction cell for the photolytic experiments proposed was constructed and awaits mating with the now operational laser.

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REACTIONS AND RELAXATION OF VIBRATIONALLY EXCITED HYDROGEN

Final Report on AFOSR Grant [redacted] AFOSR-78-3612

Jerome V. V. Kasper, Principal Investigator

One of the goals of this research was the measurement of H2(v=1) and H2(v=2) formed by the reaction of H with HI. The technique used is quantitative absorption spectroscopy on various absorption bands of H2 near 1100 angstroms in the vacuum ultraviolet. Preliminary calculations indicated that features due to HI in this region would be sufficiently weak under the desired operating conditions that quantitative spectroscopy of the transitions from the vibrationally excited H2 could be performed. This proved not to be the case. Pressures on the order of 10 to 100 millitorr of HI obscured the bands in this region. The signal/noise ratio of the original apparatus which employed sodium salicylate to down convert the vacuum ultraviolet photons to near uv-visible ones was inadequate to the task of unraveling the spectrum. A series of extensive improvements were then made.

Replacement of the McPherson lamp power supply with a Velonex pulse generator and the design and construction of the new sources materially decreased the source noise. Determination of the characteristics of the source showed that the noise was critically dependent on the repetition rate of the pulse generator and the length of an individual pulse. The Velonex generator was

operated under conditions comparable to those of the McPherson pulse generator with nearly disastrous results. For the first few microseconds following application of the high voltage, but subsequent to actual striking of the arc, the impedance is effectively infinite; after the arc strikes, its impedance is approximately 10 ohms. Operation of the Velonex under either of these loads is deleterious to its performance. By working with approximately 100 nsec pulse widths with 100 kHz repetition rate, the stability of the lamp was markedly improved. The time between consecutive pulses is short enough that ions produced by a given pulse do not disappear before the next pulse is applied so that current is conducted immediately upon application of that pulse. Pulse duration is short enough that the new ions produced by the pulse do not significantly change the lamp impedance. These changes resulted in a decrease in noise of a factor of 20.

Unfortunately the signal to noise was hampered by a new and unexpected problem. The newly designed lamp proved to be more effective at the production of color centers. Such color centers degraded the transmission of the LiF windows so rapidly, that the signal decreased in some instances by almost 70 to 90% per minute. The solution was to move the sample cell from the source side to the detector side of the monochromator. This solved the problem of the rapid degradation of the window, but spectra could not be obtained becausee the photomultiplier then in use was swamped by emissions in the visible from the products of the dis-

charged reactants. Further experiments await the full implementation of the solar blind photomultiplier tube purchased after the termination of the grant.

A major effort was the automation of the vacuum ultraviolet monochromator to permit rapid and routine acquisition of the spectra. The normal synchronous motor on the McPherson spectrometer was replaced by a stepping motor. A comprehensive software package for control and acquisition of the data was then developed. By means of this software, it is possible to take a variety of short-range scans at those wavelengths where H2 absorbs without wasting time on the uninteresting regions between those features. It is possible to scan over several transitions which have been pre-selected as being the most sensitive to changes in concentration. The analysis software determines the equivalent widths of the spectral features and converts these to pressures of H2 in specific (v,J) states.

Partial pressures of the reactants are of key importance to this study. The implementation of the computer-interfaced Baratron pressure gauge permitted greatly improved accuracy for these measurements. Computer code has been developed to permit routine calibration of the flowmeters under the actual operating conditions. The uncertainty of these measurements is less than 1% under typical conditions.

The Lumonics excimer laser arrived late in the grant. Furthermore, the laser tube cracked within weeks of its arrival. The replacement laser tube arrived and was installed just at the end of the grant. A gas-handling system for providing the flowing flourine gas mixtures was constructed and tested. Contrary to the manufacturers claims, we were able to operate the laser only when flowing the argon-flourine mixture through the laser. It would simply not operate for more than a few minutes under static fill conditions. The flow system and reaction cell for the photolytic experiments proposed was constructed and awaits mating with the now operational laser.

Although this grant has terminated, it is hoped that these experiments can be completed with the help of a contract for the next fiscal year from the AFOSR and with UCLA support.